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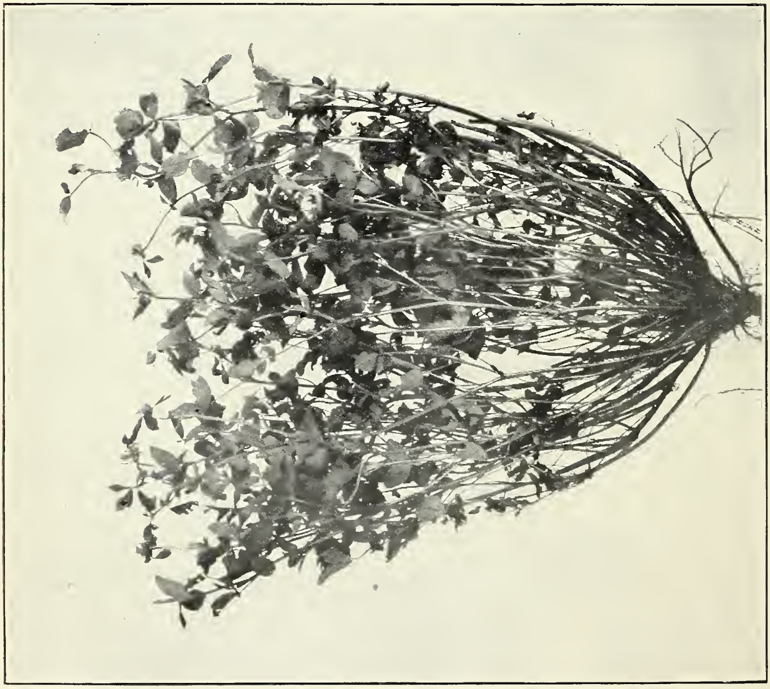

FIG. 1.—PLANT OF HAIRLESS OREL CLOVER, ALMOST MATURE.

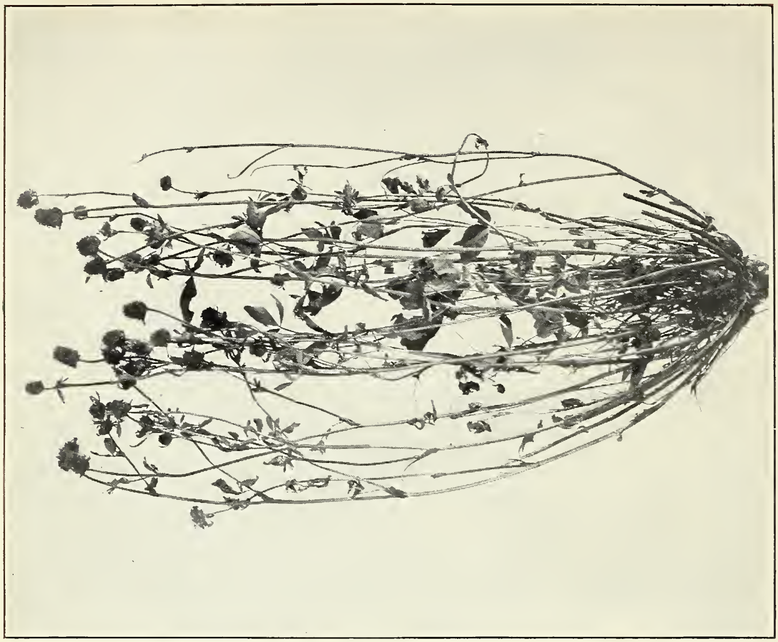

FIG. 2.—MATURE PLANT OF AMERICAN RED CLOVER.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 95.
B. T. GALLOWAY, *Chief of Bureau.*

A NEW TYPE OF RED CLOVER.

BY

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ASSISTANT PHYSIOLOGIST, LABORATORY OF PLANT
LIFE HISTORY.

ISSUED OCTOBER 3, 1906.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., July 20, 1906.

Sir: I have the honor to transmit herewith a manuscript entitled "A New Type of Red Clover" and to recommend that it be published as Bulletin No. 95 of the series of this Bureau. This bulletin was prepared by Mr. Charles J. Brand, Assistant Physiologist in Plant Life History Investigations, and has been submitted by Mr. A. F. Woods, Assistant Chief of Bureau, with a view to publication.

Considering the great extent of the area suited to its cultivation, red clover is the most important forage plant and manurial force in modern agriculture. Its high value as a feed, its power of renewing and increasing the fertility of the soil by the fixation of free nitrogen, its fitness for nearly all rotations, and the fine physical condition in which it leaves the soil on account of its root development all contribute to make success in its cultivation a matter of vital importance to the profitableness of farming in a large part of the United States.

In the course of his studies on life history, seed production, and change of seed, Mr. Brand has encountered a European strain of red clover hitherto not recognized in this country, the seed of which was obtained from Orel in the "Black Earth" region of Russia, which promises to prove of exceptional value both on account of its yielding power and the fine quality of hay which it produces.

In the accompanying bulletin are described the performance and characteristics of the plant itself, the sections where and the conditions under which its culture may be expected to produce the best results. The new type is not recommended to take the place of our home-grown strains, but to supplement them. It is not believed that it will be so well adapted to all parts of the clover region as to the Northwest, but it is hoped that it may help to extend the boundaries of the present clover-growing area.

The work covered by this report has been carried on in cooperation with the Seed Laboratory and with the assistance of the Office of Seed and Plant Introduction and Distribution, through which all seed used in the experiments was purchased.

The accompanying illustrations are necessary to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—216.

A NEW TYPE OF RED CLOVER.

INTRODUCTION.

In the course of an investigation now in progress on the life history, seed production, and change of seed of medium red clover (*Trifolium pratense*), there has appeared a hairless Russian variety, new to the United States, of such unusual promise as to make it seem desirable to publish the observations thus far recorded concerning it.

At the present time clover culture is carried on in a large, though quite well-defined area of the United States, often called the clover region, shown on the accompanying map (fig. 1). Ohio, Indiana, and Illinois are the most important clover-producing States of this region, the boundaries of which may be defined about as follows: It is limited on the north by the forty-fifth parallel of latitude; on the east by the Atlantic Ocean; on the south by the thirty-fifth parallel, and on the west by the ninety-seventh meridian. These boundaries do not, of course, mark the absolute limits of clover culture, and it is almost unnecessary to say that there are large tracts within this so-called clover region where attempts to grow red clover are not

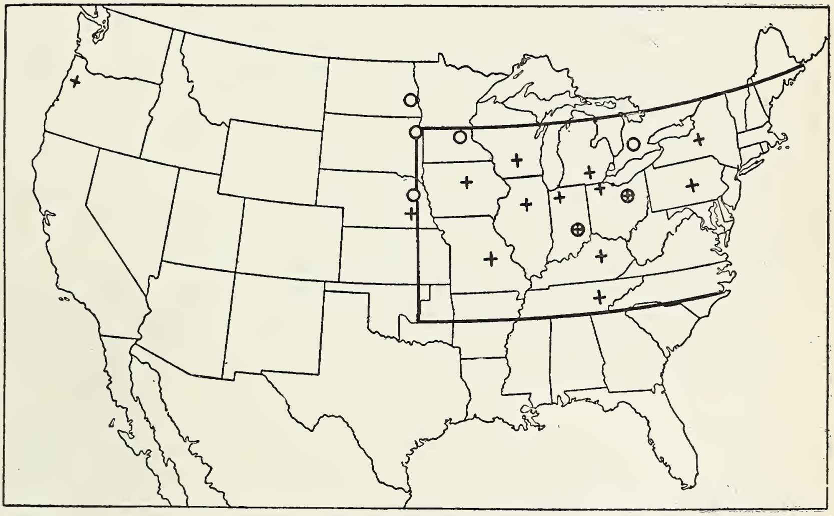

FIG. 1.—Map of the United States, showing locations of experiments (o), sources of seed (+), and general boundaries of the clover region.

attended with success. Furthermore, excellent growth is obtained in a few regions immediately adjoining this area, and there are also several sections wholly separated from it where clover is grown with notable success. Among the latter may be mentioned the Willamette Valley of Oregon, the Palouse country in eastern Washington, and also the Gallatin Valley of Montana, where red clover is being successfully and profitably grown under irrigation.

A lack of definite information has for a long time existed as to the exact life history requirements of red clover, the effect and importance of change of seed, and the relative seed and hay producing properties of the different varieties in use. It was to add to the sum of our knowledge on these and other points connected with clover culture that the present experiments were instituted.

THE IMPORTANCE OF CLOVER CULTURE.

The extraordinary importance of clover in renewing and maintaining the fertility of the soil has been amply demonstrated by the experience of thousands of American farmers and need not be dealt with to any length in this connection. It is sufficient to say that the thoroughly systematic and careful studies of recent years have proved conclusively that the beneficent effects of clover on the soil are due to definite symbiotic relationships which exist between the plant and certain bacteria inhabiting both the soil and the roots of the plants. Nitrogen, at once the most important and costly of plant and animal foods, is the element conserved in the soil or supplied from the air as the consequence of this relationship.

The need for broader knowledge concerning a plant of such vital importance to our present methods of agricultural practice is especially great just now when the status of clover culture in a large part of the clover region is so unsatisfactory. In those sections where the troubles attributed to "clover sickness" exist in an aggravated form, they threaten to make necessary new methods of agricultural practice in order to maintain farming on its present paying basis. Under the methods of farming now in vogue, red clover possesses the valuable manurial properties previously referred to in a higher degree of availability than any other leguminous crop plant at present capable of growth on a scale extensive enough to accomplish what is demanded in this direction in the large area suited to its cultivation.

These conditions make it seem advisable to place immediately at the disposal of the American farmer any facts likely to contribute to greater success in clover culture in its present well-defined area or to aid in its extension into sections where hitherto its culture has not been attempted or, if attempted, has been attended with only qualified success.

DOMESTIC VERSUS FOREIGN SEED.

The opinion has hitherto prevailed that the use of red clover seed from European sources would prove unsatisfactory and unprofitable in this country, both from a hay and seed producing standpoint. This conclusion no doubt applies correctly to the majority of European varieties of red clover, particularly those from Italy, France, and some parts of Germany, which appear to be altogether unsuited to the soil and climatic conditions of the clover-growing area of the United States.

The term "European clover seed" as used in the United States is a very loose inclusive one applied indiscriminately to all seed imported into this country from European ports. It includes not only seed grown in Europe, but also seed from South America, Canada, and the United States itself, the seed having been exported in years when the crop was large and prices consequently low only to be shipped back again to this country in years when the balance of supply and demand had shifted in the opposite direction. Inasmuch as red clover is grown to a large extent in almost all the countries of Europe and quite careful distinctions are made there between seed from a number of sources, the general designation of "European clover seed" hitherto used in this country appears altogether unwarranted and misleading. The same erroneous classification of American red clover seed is current in Europe, no distinction being made whether from New York, Tennessee, or Oregon. The following are some of the numerous regional varieties commercially well recognized in Europe: Steiermark, English, Bohemian, Russian, Danish, Swedish, and French. Some of these are again divided into early and late varieties; for example, Early Russian and Late Russian.

OBJECTIONS OF EUROPEAN GROWERS TO AMERICAN RED CLOVER.

One of the most frequent complaints made by European growers against American clover seed is on account of the dustiness of the hay produced from this seed. This dustiness is due almost wholly to the hairiness of the plant. That there is a great difference in this respect between the hairy domestic and smooth foreign types is strikingly shown in Plate II, figs. 1 and 2. The hairy form of plant shown was produced from American commercial seed, while the smooth one is a promising Russian clover from the government of Orel, designated as No. 16. This difference in hairiness is accompanied by other distinctions, the most important of which from an economic standpoint is the much greater succulence of the smooth plants and the consequently finer quality of the hay, the loss due to coarse, woody, uneatable stems being reduced to almost nothing.

HAIRY CLOVER A CAUSE OF BLOATING.

Cattle are less liable to tympanites, bloating, or hoven, if fed on the hairless Orel clover, as there is considerable evidence to prove that the hairs of the hairy varieties of clover become aggregated into balls in the rumen, and these may reach and block the pylorus or even the entrance to the stomach, becoming wedged between the lips of the esophageal groove. Either would tend to bring on bloating, which is always directly due to the fermentation of food material and the resulting formation and accumulation of gas.

That cattle prefer the smooth form to the American strains is undoubted. Mr. John P. Young, in cooperation with whom the experiments in Nebraska were conducted, states in a recent report that "the cattle fairly lick after every spear in one end of the rick for that Russian strain (No. 16), while the other end remains full of apparently just as good hay, put up at the same time and in the same way." (See Pl. I, figs. 1 and 2.)

SOME GENERAL OBJECTIONS TO THE GROWING OF CLOVER.

Two great objections have long been made against red clover culture in the area where it can be grown. One is that the hay crop matures at a time when the farmer's best interests demand that he be either cultivating his corn or harvesting his small grains. The other is involved in the fact that perhaps the most satisfactory, or at least the most popular method of seeding clover for hay or pasture is in mixtures containing either one or several of a number of grasses, including timothy, bluegrass, rye-grass, orchard grass, redtop, brome-grass, and others. Of these the most important by far is the clover-timothy mixture, and against this it has ever been argued that the clover matures so much in advance of the timothy that the feeding value of either the one or the other is sacrificed on account of the time of harvesting. This serious objection can be overcome in either one of two ways—the discovery or breeding of an earlier strain of timothy or of a later variety of clover.

Another objection to clover growing which is not infrequently heard is that the crop matures at a time in June when seasons of rainy weather are of frequent occurrence, making difficult or impossible the proper harvesting and curing of the crop, while beginning with the latter part of June rainy weather is much less common, conducing to the successful putting up of hay at this time. A cursory examination of the weather records of a number of States seems to indicate that there may be some ground for this objection.

CERTAIN OBJECTIONS OVERCOME BY NEW TYPE OF CLOVER.

The hairless Orel clover overcomes in an effectual way all the objections cited by maturing practically two weeks later than the domestic strains of medium red clover. This factor is of special importance in sections where corn is the chief crop. At the time when a farmer is compelled to put up his clover hay grown from the ordinary strains of seed it is, as a rule, of the highest importance that he be concentrating all of his energies on the cultivation of his cornfields. The corn is rapidly approaching a stage when it becomes difficult or impracticable to cultivate longer. Inability to give the crop the necessary care at this time may mean hundreds of dollars of loss in a single year.

DISADVANTAGE OF LATENESS OF MATURING UNDER SOME CONDITIONS.

There is one drawback in the lateness of maturing of the Orel strain of clover, namely, that it militates against the production of a heavy second crop. However, in southern Indiana, in a typical part of the clover section, the Kief and Orel strains gave in the order mentioned the best yields of seed after recleaning. This is a point that will receive further investigation to determine as accurately as possible by a study of their limiting conditions the regions in which the new variety can be profitably grown.

HEAVY YIELD OF FIRST CROP AND ACCRUING ADVANTAGES.

The heavy yield of the first cutting of the hairless clover should prove indirectly advantageous in wheat-growing sections, especially in the winter-wheat belt, when it is desired to hasten the rotation back to wheat, as the increased product from this cutting would, where feed production was not a paramount necessity, in a measure justify the immediate or early plowing up of the field preparatory to reseeding to wheat. On account of the dense shade which this strain gives to the soil by virtue of its heavy growth, the field is left in unusually fine physical condition for plowing up after the removal of the first crop. A rotation practice of this kind might also prove valuable by postponing for several years the clover sickness from which all soils seem destined to suffer sooner or later. In the Dakotas and some other parts of the Northwest where fall plowing is necessary this method may be especially useful on account of the fact that as freezing up occurs so soon after the maturing of the second crop it is likely to be too late to prepare the land in the autumn for spring seeding.

OTHER POINTS OF EXCELLENCE OF HAIRLESS CLOVER.

In addition to the advantage of the smooth clover already mentioned—its exceptionally large yielding power for the first crop—the fine quality and dustlessness of its hay also command attention. In reference to its yielding qualities it will be seen later on that under comparable conditions in a number of different States it has outyielded from a few hundred pounds to almost two tons all of the domestic strains that have been under test. This in itself is of great importance, but the actual gain in value is not adequately covered by this fact alone. On account of the succulence of the plants of this promising variety, the general quality and texture of the hay is so much finer that the percentage of waste, due to refusal of animals to eat hard, woody portions, is reduced to a minimum. Some observations on this point indicate that cattle waste from 5 to 10 per cent more of the coarse hay of other strains than of this hairless clover. The American strains vary considerably among themselves in this regard, but none of them compares favorably with either the Orel or Mogileff strains, particularly the former.

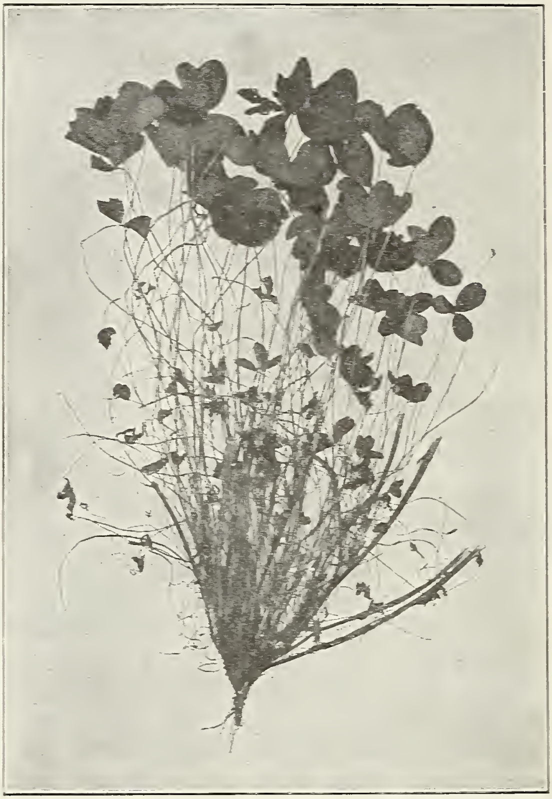

FIG. 2.—Plant of *Trifolium pratense* var. *foliosum*, showing persisting basal leaves. (One-sixth natural size.)

EFFECT OF PERSISTING BASAL LEAVES ON QUALITY OF HAY.

A point of considerable importance as regards the excellence of the hay produced by the hairless Orel clover No. 16 rests in the fact that it leafs much more profusely than the American forms. This may be seen by reference to the frontispiece (Pl. I, figs. 1 and 2).

Another feature in this connection, which is better illustrated than described, is shown in figure 2. Many leaves borne on the long stalks arising from short stems near the crown of the root persist in a growing condition until the plant is quite mature, and are cut with the hay. In the specimen from which the illustration was made the main stems were cut off, leaving only the basal leaves. Much of the leafiness observable in Plate I, figure 1, is due to the persistence of these leaves. Compared with that from American strains, a large percentage of the hay is made up of this tender leafy material, which improves its quality and increases its palatability. The American strains also produce these leaves, but not in such profusion, nor do they persist. (See Pl. I, fig. 2.) As a rule they become brown and dead, and if the weather be wet, decayed, and almost all fall off before the hay is made.

It is hoped that the smooth Orel clover will prove of permanent value especially in North Dakota and South Dakota, where clover culture is but little practiced and where on account of the waning productiveness of the soil, due to continuous cropping with wheat and other cereals, this crop is much needed for renewing and maintaining soil fertility.

LATENESS OF HAIRLESS CLOVER WITH REFERENCE TO INSECT RAVAGES.

A recent circular[a] prepared by the Bureau of Entomology calls attention to certain insects which destroy the clover seed crop and suggests as a method of preventing their ravages the clipping of the clover in May in order to cause blossoming to come on at a later date, when the danger from injury by these insects has passed. It is possible that the natural lateness of this new type of clover may accomplish this same result, thus doing away with the necessity for early clipping, which would probably make impossible the securing of more than one crop in any year.

A point of considerable interest and importance in reference to the general question of the harm done by insects was noted on the plants at Wapakoneta, Ohio. Grasshoppers were quite numerous and destructive in that section during the summer of 1905. The hairless Orel clover, known as No. 16, was not included in the experiment, but another smooth type from Kief, Russia, was tested at this place. It was found that the grasshoppers preferred the hairless clover to such an extent that they destroyed almost every plant of it, but did not molest the hairy American plants on the neighboring plats.

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[a] "Some Insects Affecting the Production of Red Clover Seed." By F. M. Webster. Circular 69, Bureau of Entomology, U. S. Department of Agriculture, 1906.

Despite the numerous advantages possessed by this variety, it is not believed that it will supplant our domestic form, but rather, on account of its maturing between two cuttings of the latter, supplement it, especially when continuous green feeding is necessary or desirable.

EFFECT OF LATENESS OF MATURING WHEN SEED PRODUCTION IS DESIRED.

In many sections the lateness of this hairless strain of clover promises to be a drawback when it comes to seed production, as in years when it is desired to secure seed it may be possible to secure only either a light crop of hay from an early cutting, a small aftermath, or a considerable amount of pasturage.

SECTIONS PARTICULARLY SUITED TO THE CULTIVATION OF THE NEW TYPE.

In such a region as the Willamette Valley of Oregon, or in any other section where the best methods of management indicate that only one crop, either of hay or seed, and a light aftermath, or some good pasturage can be advantageously expected from clover fields, the extraordinarily heavy first crop, and the free seeding capacity of the late hairless clover make it especially desirable; and under such circumstances as these it can be recommended to take the place of our domestic form.

SEED OF NEW TYPE INDISTINGUISHABLE FROM ORDINARY FORM.

Another difficult, though not insurmountable, obstacle to the general use of this variety lies in the fact that the seed itself is indistinguishable from that in common use. However, as soon as there is a supply of seed and a demand for it, trustworthy dealers will no doubt furnish seed upon which dependence may be placed. The Department of Agriculture has at the present time only sufficient seed of this variety for experimental purposes and none for general distribution. Farmers purchasing seed from foreign sources purporting to be of the same kind are urged to take precautions against allowing any foreign weed pests that may be readily imported with the seed to gain a foothold in their fields. A number of the State experiment stations and the Seed Laboratory of this Department make purity and germination tests without charge; hence, a farmer before purchasing seed should avail of these facilities for insuring himself against introducing into his farm dangerous weeds or from buying seed of low germinating power.

In the following pages are given in detail the data concerning each of the strains experimented upon, special attention being given to the hairless Orel clover.

PLANS OF EXPERIMENTS, ORIGIN OF SEED, AND METHODS OF PROCEDURE.

For the present experiments about thirty regional varieties [a] of red clover seed were secured from as many domestic and foreign sources. Each station and individual cooperator has been furnished with a series including from 16 to 21 of these strains, and these are being grown side by side, in most cases on acre plats, under as nearly uniform conditions as possible. The varieties came from sources having a great diversity of climatic and soil conditions and methods of cultivation, and are now being grown under a range of conditions representing scarcely less diversity than those under which they originated. Twenty States are represented in the whole experiment, but of this number it is proposed to deal here only with those localities where the promising Russian variety before mentioned is being grown: Minnesota, North Dakota, South Dakota, Nebraska, Indiana, Ohio, and Ontario.

The circles on the sketch map of the United States (fig. 1) show the approximate location of each of the stations, while the crosses indicate the general region of each State from which the strains of known American origin were secured.

In the case of domestic varieties, every effort was made to secure seed that had been grown in the region of origin for a period of years and whose ancestry could as a consequence be followed to some extent. In most instances the American strains used are directly traceable to the identical field which produced them, and soil samples have been secured for examination and comparison with the soils into which they were transplanted. In the present bulletin only those varieties grown in comparison with clover No. 16, the promising Russian variety, will be discussed. All of the seed used in the work was secured by the Office of Seed and Plant Introduction and Distribution, the foreign seed through Dr. E. A. Bessey and that of home-grown varieties through the writer.

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[a] The term "variety" is not used in its strict botanical significance, but is employed to designate seed from more or less widely separated sources.

The following table shows the region of origin of each strain grown in the different localities:[a]

TABLE I.—*Source of clover seed used in experiments and the localities in which it was tested.*

Source of seed.	Where tested.						
	Nebraska.	South Dakota.	Minnesota.	North Dakota.	Indiana.	Ohio.	Ontario, Canada.
1. Commercial seed (Western Bulked)	+	−	+	+	−	+	+
2. Western Ohio	+	+	+	+	+	+	+
3. Northern Indiana	+	+	+	+	+	+	+
4. Southern Indiana	−	+	+	+	−	+	+
5. Illinois	+	+	+	+	+	+	+
6. Missouri	+	−	+	+	−	+	+
7. Iowa	+	+	+	+	−	+	+
8. Commercial seed (not inoculated)	+	+	−	+	+	+	+
9. Commercial seed (inoculated)	+	+	+	+	+	+	+
10. Michigan	+	+	+	+	+	+	+
11. Nebraska	−	+	−	+	+	+	+
12. Eastern Ohio	+	−	+	+	+	−	+
13. Kentucky	+	+	+	+	+	+	+
14. Tennessee	−	+	+	+	+	+	+
15. Kief, Russia	−	−	+	+	−	+	+
16. Orel, Russia	−	+	−	+	−	+	+
17. Mogileff, Russia	+	−	+	+	−	+	+
18. Courland, Russia	−	−	−	+	−	+	+
19. Wisconsin	−	−	+	+	−	−	+
20. Oregon	+	−	−	+	+	−	+
21. Pennsylvania	−	−	−	−	+	−	+
22. New York	−	+	−	−	−	−	+

SOURCES OF RUSSIAN CLOVER SEED EXCEPT NO. 16.

Four Russian varieties were included in that part of the experiment under discussion, but, as may be seen by reference to Table I, not all of these were included in the series tested in each of the six States. Russian seed No. 15 was purchased in the open market under the trade name "Russian Rio." This seed was grown in the Province of Kief, in southwestern Russia, and, in common with all other strains used in this test, is of the crop of 1903. Seed from this same region, but of a previous crop, made a particularly good showing in Wisconsin in 1903, producing a plant that appeared to possess several excellent qualities not common to our own domestic strains. On this account a special effort was made to include a sample of this seed in these comparative experiments. Its productiveness and quality in 1903 were fully equaled in 1905, and but for the superior performance of No. 16, with which it has many points in common, it might well be recommended for use in the Northwest and elsewhere to take the place of our domestic strains. It has in all cases proved to be, like No. 17, intermediate in lateness of maturity, being later than No. 18

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[a] The minus sign indicates that the strain opposite which it occurs was omitted from the series grown in the State specified.

and all the American strains, but earlier than No. 16, to which later experiments may show it to be superior under certain climatic and soil conditions.

Of the other three Russian varieties, Nos. 17 and 18 were secured from the following sources: No. 17 (S. P. I. No. 10533) was grown by M. Legsdin, near Shlobin (52° 50′ N., 30° E.) in the valley of the Dnieper, in the southern part of the Mogileff government, and was purchased from Mr. Heinrich Goegginger, of Riga. No. 18 (S. P. I. No. 10534) was obtained through Fr. Lassman, of Riga, and was produced near Neuhof (24° 35′ E., 56° 53′ N.), in the Baltic Province of Courland, on the estate of M. Sellin.

SOURCE FROM WHICH RUSSIAN SEED NO. 16 WAS OBTAINED.

The seed of the promising hairless clover No. 16 (S. P. I. No. 10532), to which it is desired to call special attention, was obtained by Dr. E. A. Bessey through H. Goegginger, of Riga, and was produced on the estate of a German grower near Yeletz, in the eastern part of the Orel government. The grower made a practice of saving his own seed, and hence this strain had been grown on the same estate for a number of years.

According to Mr. Goegginger, the government of Orel furnishes the best red clover seed obtainable in Russia. Its chief crops are winter rye and oats, and it is in rotation with these that the clover is grown. A small quantity of winter wheat is also grown.

THE SOIL AND CLIMATE OF OREL.

Yeletz is situated about longitude 38° E. and latitude 52° N., and lies well within the famous "Black Earth" or Tchernozom region of Russia. This region, comprising about 250,000,000 acres of the most fertile soil in the world, resembles strikingly in many features of both soil and climate our own Great Plains region. According to Sibirtzew[a] the Tchernozom extends from the Austrian and Roumanian frontier in a general east by northeast direction, forming a great band, varying in width from 250 to 650 miles, across the whole empire. The climate of this wonderfully fertile area is typically continental. The average mean annual rainfall of this region varies ordinarily between 16 and 22 inches and the temperature ranges from 30° F. or more below to more than 100° F. above zero.

According to Murchison, Verneuil, and Keyserling,[b] the black soil of the eastern part of the Orel government is especially rich in marl and limestone. In the light of our knowledge on the general beneficial effects of liming, it appears altogether probable that this factor may contribute to a considerable extent to the success of clover growing in this area.

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[a] Etude des Sols de la Russie. Compte Rendu Congrès Géologique International, St. Petersburg, 1899, pp. 73–125.

[b] The Geology of Russia in Europe and the Ural Mountains, London, 1846, Vol. II, pl. 6.

Orel occupies an elevated position in comparison with the governments which border it on the south; on this account its climate resembles more strikingly that of the states that bound it on the north. Its relatively high altitude, exposing it completely to the winds, is the cause of the more or less sudden changes in temperature to which this area is subject. These changes are induced by the warm winds which come from the south, southeast, and east, and by the cold winds from the north, northwest, and west. The mean annual temperature at Orel, the nearest point to Yeletz for which complete meteorological observations could be found, is 40.9° F. The seasonal means are as follows: Spring, 38.48° F.; summer, 66.11° F; autumn, 43.08° F.; winter, 15.08° F. The absolute maximum temperature thus far observed is 97.5° F., while the absolute minimum is $-29.2°$ F. An average for a period of years shows 107 clear days, 127 with rain or snow, and 131 variable. The normal annual precipitation is 20.2 inches. The rivers of the Orel government are covered with ice on an average for 119 days during the year—from the first part of December until early in April. The climate will thus be seen to be a relatively temperate, continental one, resembling that of central Russia in general, but having somewhat more variable atmospheric conditions which often prove unfavorable to agriculture. Devastating storms are not infrequent in summer, while snowfalls accompanied or followed by high winds are common in winter.

From this brief characterization of the climatic conditions of the region from which Russian seed No. 16 was obtained, its likeness to that of our own northwestern prairie country can be easily seen, and added reasons for the promise of this strain of red clover in the Northwest are readily discernible. A beneficial change of seed has been accomplished between two regions having typically similar climatic conditions and soils that are singularly alike both in mechanical structure and chemical composition. The presence in both of a relatively large quantity of lime in a perfectly combined state is perhaps one of the most important similarities between these two widely separated soil areas.

The following table summarizes the more salient climatic features of Orel and the regions of America where clover No. 16 has already been grown and where, on the basis of the showing made in the growing season of 1905, the best results may be expected from its future cultivation:

TABLE 11.—*Temperature and rainfall of Orel, Russia, and certain localities in America.*

Location.	Temperature.						Precipitation.	
	Mean annual temperature.	Normal mean for January.	Normal mean for July.	Mean temperature of growing. season.	Absolute minimum.	Absolute maximum.	Normal annual rainfall.	Normal rainfall of growing season
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*
Orel	40.4	13.4	66.8	61.59	−29.2	97.5	20.2	10.62
St. Paul, Minn.[a]	43.3	10.6	71.5	65.02	−41	104	26.99	17.39
Milbank, S. Dak.[b]	43	13.1	70.5	65.1	−34	107	20.73	13.73
Fargo, N. Dak.	38.7	5.4	68	62.5	−48	102	20.83	13.66
Tekamah, Nebr.[c]	49.2	22.7	75.3	68.7	−24	106	31.98	22.90
Guelph, Ontario	42.05	16.9	68	60	....	....	28.48	12.80

[a] St. Anthony Park, where these experiments were conducted, lies about midway between St. Paul and Minneapolis, Minn.

[b] No meteorological data are available for Bigstone, S. Dak.; hence the observations for Milbank, a point 11 miles distant, are here given.

[c] No meteorological data being available in the case of Oakland, Nebr., the records of Tekamah, a point 16 miles distant, are used.

PURITY AND GERMINATION OF SEED USED IN EXPERIMENTS.

In purchasing the different lots of seed used in the work, the greatest care was exercised to secure samples as free as possible from troublesome and injurious weeds, particular care being used with reference to dodder. All of the seed was of high average quality both as to purity and germination. The average purity of all samples as distributed for seeding was 98.13 per cent. As may be seen by an inspection of the following table, the seed showing the highest percentage of purity was that from Oregon, containing 99.68 per cent of pure seed, while the seed grown in New York contained the highest percentage of impurities, 7.46 per cent, or 92.54 per cent of pure seed. Every sample was screened from two to six times, one even twelve times, in order to remove as many of the impurities as possible.

The average germination of all samples was 87.07 per cent, the lowest percentage being 58.2 per cent for the seed from Courland, Russia; the highest, 99.12 per cent for the seed from eastern Ohio. Red clover seed germinating from 90 per cent to 95 per cent is generally considered as representing a satisfactory commercial product.

TABLE III.—*Purity and germination of red clover seed distributed in the spring of 1904.*

No.	Source of seed.	Purity.	Germination.
		Per cent.	*Per cent.*
1	Commercial seed (Western Bulked)	99.58	94.25
2	Western Ohio	98.42	75.62
3	Northern Indiana	97.7	88.2
4	Southern Indiana	98	94
5	Illinois	99	92.87
6	Missouri	96.8	88.27
7	Iowa	98.4	82.75
8	Commercial seed (not inoculated)	99.28	95.25
9	Commercial seed (inoculated)	99.28	95.1
10	Michigan	99.58	94.62
11	Nebraska	96.66	85.37
12	Eastern Ohio	99.56	99.12
13	Kentucky	99.48	73.87
14	Tennessee	97.98	92.5
15	Kief, Russia	98.4	86.75
16	Orel, Russia	95.5	87.87
17	Mogileff, Russia	98.34	91
18	Courland, Russia	97.62	58.2
19	Wisconsin	98.6	84.7
20	Oregon	99.68	91.51
21	Pennsylvania	97.58	91
22	New York	92.54	92.57

DETAILED DESCRIPTION OF EXPERIMENTS.

As previously stated, all of the seed used in these experiments was produced in the crop year 1903 and all of the experimental areas under discussion were sown in the spring of 1904. The observations made in each State will be discussed separately.

THE EXPERIMENT IN NEBRASKA.

LOCATION.

The work in Nebraska was carried on in cooperation with Mr. John P. Young, on his farm near Oakland, Burt County. This place is situated at about latitude 41° 50′ N. and longitude 96° 26′ W., in the Elkhorn Valley, near the present western limit of successful clover culture.

SOIL.

With the exception of a streak of limited extent, where the subsoil crops out, the soil of the clover field is a silted sandy loam of dark gray color and of such structure that with insufficient moisture it becomes aggregated into a hard, almost impenetrable mass. After rains it becomes very plastic and tenacious, very much resembling clay in this respect. On account of this character a large part of the soil of the Elkhorn Valley has become known under the name "clayland." This soil is further distinguished by a comparatively large percentage of well-distributed calcareous matter. This is a factor of great importance to successful clover culture, and no doubt helps to account for some of the heavy yields obtained in this soil.

DRAINAGE.

On account of a moderate slope in two directions the drainage of the experimental plats is excellent, none of them being so situated as to be in danger of suffering injury on account of standing water. The field contains 21 acres and was divided into as many equal parts, one being devoted to each of the regional varieties under test. In 1902 the field bore a crop of oats and in 1903 of corn.

PREPARATION OF LAND AND SEEDING.

In preparing the seed bed for the clover, the land was double disked with a pulverizing machine and well leveled with a common harrow.

Oats were used as a nurse crop, one half of all plats being sown to the Early Champion variety, the other half to the Kherson oats, a variety of Russian origin that has proved exceedingly valuable in Nebraska. The oat crop was harvested just after the middle of July, the Kherson variety yielding 35 and the Early Champion 25 bushels to the acre.

The clover was sown at the same time as the oats. Seeding began on April 15, but on account of unavoidable delays due to inclement weather was not completed until April 21. The seed was sown at the rate of 10 pounds to the acre, and by April 25 seedling plants had appeared on all the plats. After July 23, when the removal of the oat crop was completed, the clover had the whole use of the land. By the time for the cutting of the oats the clover had made a sufficient growth to be slightly clipped by the harvesting machine. Except for a light pasture with calves in November no further treatment was given the crop during the growing season of 1904

GENERAL WEATHER CONDITIONS DURING 1904.

The general condition of the weather throughout the season was favorable to securing a good "catch" of clover. There was plenty of rainfall during the season as a whole and no extended or injurious periods of drought occurred, although during September the dryness was sufficient to cause the soil to become very hard, as is characteristic of it when even moderately dry conditions prevail long enough.

COMPARISON OF STRAINS OF CLOVER ON ENTERING THE WINTER OF 1904.

According to notes taken by Mr. Young about the middle of November, 1904, there was a great degree of diversity in the general thriftiness of the various strains of clover when they entered the winter. In view of the data secured in 1905 the fact that the Iowa plat represented the normal or mean condition of all plats, the Nebraska strain standing next below it, is significant. In the data for the crop year 1905, given in Table VI, it will be noted that Nebraska seed gave the lowest yield and Iowa seed next to the lowest. Taking Iowa as representing the average condition, the departure of each of the strains from the average is shown by the following table:

TABLE IV.—*Comparison of stand obtained from seed from various localities on plats at Oakland, Nebr., autumn of 1904.*

Above normal.			Normal.		Below normal.		
No.	Source of seed.	Rank.	No.	Source of seed.	No.	Source of seed.	Rank.
20	Oregon	1	7	Iowa.	11	Nebraska	1
5	Illinois	2			8	Commercial seed (not inoculated).	2
2	Western Ohio	3			9	Commercial seed (inoculated).	3
12	Eastern Ohio	4			15	Kief, Russia	4
19	Wisconsin	5			16	Orel, Russia	5
10	Michigan	6			17	Mogileff, Russia	6
21	Pennsylvania	7			18	Courland, Russia	7
3	Northern Indiana	8					
4	Southern Indiana	9					
14	Tennessee	10					
6	Missouri	11					
13	Kentucky	12					

This table shows that when winter set in in 1904 the plats sown to Kentucky, Missouri, and Tennessee seed were the most promising, in the order given. Two of those ranking below normal proved to be the best when the hay was harvested in 1905. These were the Orel clover No. 16 and the inoculated trade sample.

According to notes taken by Mr. Young, the plants produced by seed No. 16 were at this time "the weakest, most delicate, and farthest below normal" of any of the varieties included in the experiment. In view of the fact that in 1905 this clover outyielded the best of all the others by more than 1,000 pounds, this note is of unusual interest. Mr. Young further states that "it resembles somewhat the common white clover, only the plants are larger; but the leaves have that same appearance and are smaller than those on any of the other plats."

The winter of 1904–5 was quite severe, with temperatures reaching as low as 30° F. below zero. There were some days whose maximum only reached −20° F. However, as there was an abundance of snow the clover plants on all plats were adequately protected, and there was apparently no loss due to winterkilling. Without exception the plats were in excellent condition in the spring of 1905.

COMPARISON OF EARLY GROWTH OF CERTAIN STRAINS OF CLOVER.

By May 10 the different strains of clover had made average growths varying from 1 to 5 inches. The plat sown with Missouri seed showed the greatest average growth, while the Russian seed No. 18, from the Baltic Province of Courland, grew the least. The former had an average height of from 4 to 5 inches; the latter, from 1 to 2 inches. Despite this great discrepancy in early growth, the Russian strain was in bloom almost as soon as the Missouri strain and was ready for harvest in advance of it. The hay crop of the former was cut on June 20; that of the latter, June 21. Unlike the Baltic strain, the Orel clover was the latest of all in coming into bloom, as well as the latest in coming to proper maturity for harvesting. It was harvested on July 11. It will be seen from this that a period of exactly three weeks elapsed between the date of cutting of the earliest and the latest strains. This fact is of direct importance under some conditions, as will be pointed out later.

WEATHER DURING GROWING SEASON OF 1905.

The weather during those months of the growing season preceding the cutting of the hay crop was in all respects favorable. The growth of the clover began in March, which month had a mean temperature of 44.8° F., more than 8.4 degrees below the normal. The mean temperature for April was 48.4° F., which is 3.2 degrees below the normal for that month. The precipitation aggregated more than 5 inches, 2 inches above normal. The temperature for May, 58.9° F., was 2.4 degrees cooler than the established normal for that month, while the precipitation, 4.76 inches, was practically normal. The June temperature of 70° F. was very near the normal, but the rainfall for that month, 2.75 inches, was more than 3 inches less than normal. None of the plats seemed to have suffered any injury despite the seeming dryness of the month. In July again the temperature was normal, while the rainfall was about 2 inches below normal.

EARLINESS OF VARIETIES AND ORDER IN WHICH THEY MATURED.

On account of their reaching maturity at practically the same time, the strains were harvested in the following groups. The varieties in each group are arranged as nearly as possible in the order of their earliness. The groups themselves are given in the same order, the earliest being first:

Group I.—Courland, Russia; Nebraska; Pennsylvania.
Group II.—Missouri; Iowa; Kentucky; Wisconsin.
Group III.—Eastern Ohio; Oregon.
Group IV.—Tennessee; Kief, Russia.
Group V.—Illinois; northern Indiana; Michigan; southern Indiana; northwestern Ohio.
Group VI.—The commercial samples, Nos. 1, 8, and 9; Mogileff, Russia; Orel, Russia.

Despite the fact that the earliest and latest maturing kinds are of Russian origin, it will be noted that the American strains present almost as great diversity in this regard. However, leaving out of consideration the commercial samples whose region of origin is unknown, the latest of the American strains of known origin is that from northern Ohio, which was grown west of Toledo near the northern boundary of the State. This strain came into bloom only nine days later than the earliest of the American kinds, that from Nebraska. It will be seen from this that the range of maturing time of the American strains that are traceable to their region of origin as compared with the Russian varieties is very short indeed.

The table given below shows the date of full bloom of the earliest and latest American and Russian varieties:

TABLE V.—*Date of full bloom of earliest and latest American and Russian strains of clover.*

Earliest Russian.		Earliest American.		Latest American.		Latest Russian.	
Source.	Date.	Source.	Date.	Source.	Date.	Source.	Date.
Courland	June 20	Nebraska	June 20	Western Ohio.	June 29	Orel	July 11

Concerning the commercial samples used, it should be said that they were of most unusual purity, as well as of high average germination. The seed itself was very large and of a deep purple color, while the plants produced were coarse and hairy. This form seems to stand intermediate between the medium red, with which this experiment deals, and the well-known "mammoth" form of *Trifolium pratense*, which it resembles in some respects. Nothing is known as to the origin of this seed further than that it is supposed to have been produced in the Middle West. It came into full bloom on July 6, seven days later than the latest of American strains of known origin, and five days earlier than No. 16, the hairless form from Orel.

On account of the coarse, woody stems of the Western Bulked clover, there is a large percentage of waste in feeding its hay, the cattle refusing to clean it up as they do some of the other strains, notably No. 16. On account of the excessive hairiness of both stems and leaves the hay is very dusty, and hence not a pleasant and desirable feed.

The hay product of each of the different plats is shown by the following table:

TABLE VI.—*Comparison of yields of hay of regional varieties of red clover at Oakland, Nebr., in 1905.*[a]

No.	Source of seed.	Yield of hay.	No.	Source of seed.	Yield of hay.
		Pounds.			*Pounds.*
1	Commercial seed (Western Bulked)	5,700	12	Eastern Ohio	5,080
2	Western Ohio	4,980	13	Kentucky	5,540
3	Northern Indiana	4,780	14	Tennessee	4,670
4	Southern Indiana	5,020	15	Kief, Russia	5,840
5	Illinois	4,990	16	Orel, Russia	7,100
6	Missouri	5,010	17	Mogileff, Russia	5,750
7	Iowa	3,950	18	Courland, Russia	4,750
8	Commercial seed (not inoculated)	5,750	19	Wisconsin	4,950
9	Commercial seed (inoculated)	6,040	20	Oregon	4,930
10	Michigan	5,570	21	Pennsylvania	4,460
11	Nebraska	3,590			

[a] On account of a misunderstanding, the plats were not sown in serial order as given, but as follows: 11, 7, 1, 9, 8, 20, 10, 5, 3, 4, 2, 12, 19, 6, 13, 14, 15, 16, 17, 18, 21.

The first crop only was harvested for hay, the second being left to go to seed. The seed production of the various strains will be made the subject of further study.

The product of the plats sown with Western Bulked, Illinois, Iowa, Michigan, Nebraska, and Oregon seed was slightly reduced by a streak of subsoil which cropped out in these plats and on which the stand was not so perfect as on the other parts of the field. The resulting difference would amount to but a small percentage and would not modify materially the results as tabulated.

The Missouri plat was slightly injured in the spring by the work of ground moles, but seemed to have fully recovered from the injury before the cutting of the hay crop.

The only plat upon which any dodder appeared was that sown with the seed from Tennessee. It was promptly subdued and practically no harm resulted from it.

Although it would be unsafe to generalize from the results of one year's observation, it is interesting to note the fact that the seed produced in Nebraska and Iowa gave the lowest yields. This may be partially explained by the inferiority of the stand caused by the clay streak referred to above. However, it appears to the writer that this explanation is inadequate in view of the fact that the commercial samples which were grown on adjoining plats show no corresponding reductions in yield. As noted above, the Michigan, Illinois, and Oregon plats were crossed by the same streak of clayey subsoil.

YIELD OF THE OREL CLOVER COMPARED WITH OTHER STRAINS.

The total yield of all plats was 108,220 pounds, or about 54.1 tons. The highest yield was that of the hairless Orel clover, 7,100 pounds per acre; the lowest was from the Nebraska seed, 3,590 pounds, while the average for all plats was 5,153 pounds. It is interesting to note that three of the four Russian strains yielded considerably above the average for all plats.

The Orel clover No. 16 yielded 3,510 pounds of hay to the acre more than the Nebraska clover, giving a product almost double that of the latter. It produced more than 1,000 pounds more than its nearest competitor, one of the commercial samples, and almost a ton above the average for all plats.

THE EXPERIMENT IN SOUTH DAKOTA.

LOCATION.

The work for South Dakota is being carried on in cooperation with Flam Brothers on their farm near Bigstone, Grant County. Bigstone, which is situated 54° 10′ north latitude, 96° 26′ west longitude, is in the northwestern part of the State. This station represents fairly well the conditions typical of eastern South Dakota and western Minnesota.

As in the case of Nebraska, the experimental plats were each an acre in extent, and the series of 22 varieties used was identical with the one grown in Nebraska, except that seed from New York was added.

SOIL AND DRAINAGE.

The field is a piece of bottom land bordering on a small creek. The soil, which is derived from the washing down of the surrounding prairie upland, is a black, sandy loam. The sand varies from medium to fine. The soil is productive, yielding excellent crops of wheat, oats, barley, corn, and millet. It is quite rich in calcareous matter. No definite rotation of crops including a legume has been practiced, and this is the first time the land has ever borne a crop of clover. On account of the excellent natural drainage due to the permeability of the soil and the elevation above the level of the creek it has not been necessary to resort to artificial drainage on the tract.

PREPARATION OF LAND, SEEDING, AND SUBSEQUENT TREATMENT.

No chemical fertilizers have ever been used on the field. In the spring of 1903 the tract was given a heavy dressing of barnyard manure, which was thoroughly worked in by the preparation given the land and by the cultivating of a corn crop planted that year. In the preceding year, 1902, the tract had grown barley and millet.

In preparation for the clover and the accompanying nurse crop of barley the land was deeply plowed in the fall of 1903, and in the spring of 1904 was harrowed until the seed bed was in suitable condition. The seeding of the barley, which was drilled in, took place during the last days of April. It was harvested in July, the field yielding an average of 50 bushels machine measure to the acre.

The clover was sown broadcast on May 5, and then lightly harrowed in. Before the tenth of the month, the first sprouts had appeared on each of the 22 plats.

After the removal of the nurse crop, no subsequent treatment was given the field during the growing season of 1904. Despite the fact that an unusual growth was made by the clover before wintering in, it was neither clipped nor pastured, on account of the uncertainty as to the effect this would have on the plats coming through the winter. The growth left on the field formed an excellent binder for holding the snow. This gave the plants a good protection from the cold during the winter, which in this latitude is very rigorous.

Observations made in October, about the time of the frost which terminated growth for the season, showed, as in the case of Nebraska, considerable variation in the habit and development of the various plats, but on none of the plats was there any evidence of any failure to secure an excellent stand.

WEATHER CONDITIONS DURING 1904 AND 1905.

The state of the weather throughout the season was exceedingly favorable, there being plenty of moisture at all times. This is a factor of no small importance, especially at the critical period following the removal of the nurse crop. The loss sustained by the various strains on account of winterkilling during the winter of 1904–5 was comparatively small and probably did not reach more than 5 per cent in any case. The Missouri and Tennessee clovers were the worst sufferers in this respect among the American forms. The loss by winterkilling had no perceptible effect on the yield so far as could be observed; at least, the heaviest losers on this account were by no means those giving the lightest yields.

The weather for the months of April, May, June, and July, during which the growth of the hay crop took place, was decidedly abnormal for this section. The mean temperature for each of these months was below normal from 2.5 to 4.6 degrees. The precipitation, as is generally the case in comparatively cool seasons, was far above normal for each of these months, except April, when it fell below normal.

The weather records at Milbank, 11 miles distant, give the following data for these months in 1905:

TABLE VII.—*Temperature and rainfall at Milbank, S. Dak., during the growing season of 1905.*

Month.	Temperature.		Precipitation.	
	Mean for month.	Departure from normal.	Total for month.	Departure from normal.
	° *F.*	° *F.*	*Inches.*	*Inches.*
April	42.2	−2.7	1.25	−0.96
May	52.4	−4.6	7.35	+4.50
June	63 1	−2.5	8.60	+4.82
July	67.4	−3.1	5.27	+2.65

As in the case of Nebraska, there was great variation in the dates of first and full bloom; but inasmuch as careful notes of the actual dates were not kept, through inadvertence, it is impossible to report in detail on these points.

The first sample to come to the proper maturity for harvesting was that from Oregon, followed soon by the New York and Pennsylvania plats. A period of very rainy weather which followed the cutting and curing of these plats made it impossible for a time to proceed with the harvest, and on the night of July 3 came a veritable cloudburst, more than 5 inches of rain falling. The neighboring creek overflowed its banks, inundating the whole bottom and submerging the clover plats with from 6 inches to several feet of water.

This misfortune threatened to make impossible the securing of further data concerning the varieties. However, the excellent drainage of the field saved it from serious injury, and at the end of a week it was possible to proceed with the harvest.

The following table shows the yield of cured hay produced by each of the strains used in the experiment at this place:

TABLE VIII.—*Comparative yield of hay of various strains of clover at Bigstone, S. Dak., in 1905.*

No.	Source of seed.	Yield of hay.	No.	Source of seed.	Yield of hay.
		Pounds.			*Pounds.*
1	Commercial seed (Western Bulked)	4,400	12	Eastern Ohio	4,640
2	Western Ohio	3,500	13	Kentucky	3,420
3	Northern Indiana	2,510	14	Tennessee	3,970
4	Southern Indiana	2,710	15	Kief, Russia	4,080
5	Illinois	3,990	16	Orel, Russia	5,610
6	Missouri	4,450	17	Mogileff, Russia	4,030
7	Iowa	4,130	18	Courland, Russia	3,280
8	Commercial seed (not inoculated)	3,998	19	Wisconsin	2,970
9	Commercial seed (inoculated)	4,312	20	Oregon	4,560
10	Michigan	4,400	21	Pennsylvania	1,800
11	Nebraska	4,500	22	New York	2,400

COMPARISON OF YIELDS.

The low yields of the samples of clover from western Ohio and northern Indiana are due to the injury they received from the flooding previously mentioned. A "run," or former creek bed, which extended diagonally across these two plats was transformed into a torrent and did considerable damage to both of them. With these exceptions the injury by water was equal on all plats. The comparatively low yield of the New York and Pennsylvania strains may be explained, in part at least, by the fact that the west side of the field, along which these were sown, had not been under cultivation as long as the remainder of the field and hence was not so well subdued.

The total yield of cured hay from the 22 acre plats was 87,982 pounds, an average of 3,998 pounds, or nearly 2 tons, to the acre. Leaving out of consideration the plats that suffered from apparent external injuries, the plat sown with Wisconsin seed gave the lowest yield of the domestic varieties, while that sown with seed from eastern Ohio gave the highest yield. The yield of the former was 2,970 pounds, something more than 1,000 pounds below the average for all plats, while that of the latter, 4,640 pounds, was about 650 pounds greater than the average.

As was the case in the experiments at Oakland, Nebr., the hairless Orel clover No. 16 gave not only the heaviest yield among the

Russian strains, but it outyielded every other variety used in the experiment. It produced 5,610 pounds of cured hay to the acre, which is more than three-fourths of a ton (1,612 pounds) better than the average for all plats, almost 1,000 pounds more than the best American strain (that from eastern Ohio), and more than a ton and a quarter (2,640 pounds) more than the lowest yield of the domestic strains growing under like conditions (that from Wisconsin).

In addition to its great yielding power, the other excellent qualities of this strain as observed in Nebraska were reproduced in South Dakota. The marked absence of hairiness on both stems and leaves, the erectness of habit, the profuseness of leafage, the comparative lack of waste on account of hard, woody stems, and a number of other desirable qualities were all strikingly apparent.

THE EXPERIMENT IN MINNESOTA.

LOCATION, SOIL, AND DRAINAGE.

The experiments in Minnesota were carried on on the University farm at St. Anthony Park, with the cooperation of the division of agriculture of the Experiment Station and School of Agriculture. The work here was instituted under the direction of Prof. W. M. Hays, and is now being carried forward with the assistance of Mr. A. D. Wilson, of the station staff. St. Anthony Park is located midway between Minneapolis and St. Paul at about latitude 44° 58′ N. and longitude 93° 90′ W.

In this experiment two series of plats were used on rather widely separated fields. The plats of one series were one-twentieth of an acre in extent, and the product of these was used in determining by weight the amount of green matter produced by each strain. The plats of the other series had an area of one-fourth of an acre each, and were devoted to securing data as to the production of cured hay. According to Hays and Boss[a] both the soil and immediate subsoil of the University farm are of medium texture, containing clay and sand mixed in such proportions as to facilitate a rather free absorption of the rainfall which penetrates to a considerable depth and is well conserved in seasons of moderate drought. At a depth of 5 or 6 feet, however, the mixture of clay and sand gives way to gravel and sand. This furnishes excellent underdrainage in years of abundant or superabundant rainfall, but is a serious drawback in years of drought, as it tends toward the dissipation of a part of the water supply of the crops through this deeper porous subsoil. The surface drainage, as well as the underdrainage, of both areas used in this experiment was excellent.

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[a] Bulletin No. 62, Agricultural Experiment Station, University of Minnesota, March, 1899.

PREPARATION OF LAND, SEEDING, AND SUBSEQUENT TREATMENT.

Field F, which was used in making the green-matter determinations, was sown to Canada field peas in 1902, and in 1903 was used in the variety testing of cereals. The field was fall-plowed in 1903 and in the spring was disked and harrowed preparatory to seeding with clover. Spelt was used as a nurse crop. The clover seed and the spelt were mixed and sown with a drill.

Field W, from which the data as to field-cured hay was secured, bore a crop of fodder corn in 1902, and was manured and again sown to fodder corn in 1903. In preparation for the clover it was thoroughly disked and harrowed. The clover seed was drilled in to a depth of from 1½ to 2 inches, having been first mixed with the Minnesota No. 169 wheat, which was used as a nurse crop.

No treatment such as pasturing or clipping was given the field after the removal of the spelt and wheat.

WEATHER CONDITIONS DURING 1904 AND 1905.

The weather throughout the season of 1904, despite the fact that the temperature in most months was a little below normal, was quite favorable to securing a good "catch" of clover. The last killing frost in spring occurred on May 15, and the first in autumn on October 6. There was a plentiful supply of moisture at all times, the precipitation of every month during the growing season exceeding the normal.

According to notes taken shortly before the first killing frost of autumn, there was a fair stand on all plats at that time. The weakest strains were those from Tennessee, Orel, and Kief, while among the most vigorous were those from Ohio, Indiana, Wisconsin, and Iowa.

The winter of 1904–5 was rather severe on the whole, the means for both January and February being several degrees below normal. The minimum temperature recorded was 26° F. below zero.

No marked loss due to winterkilling was noted on any of the varieties under experiment, but on account of the coolness of April practically no growth was made until the last week of the month.

COMPARATIVE CONDITION OF DIFFERENT STRAINS OF CLOVER IN THE SPRING OF 1905.

On May 13 observations were made on the comparative condition of the stand on all the plats. According to these, of the seeds from domestic sources the strains from eastern Ohio, northern Indiana, and the commercial samples made the best showing at this time. The poorest of the domestic strains at this time were those from Tennessee, Missouri, Nebraska, Michigan, and Illinois. The best of the Russian strains were Nos. 15 and 17, from the Kief and Mogileff governments, respectively, while the poorest were Nos. 16 and 18, from Orel and Courland.

The best strain of known origin according to the observations of May 13 was that from eastern Ohio, while the poorest was that from Courland.

YIELDS OF GREEN MATTER.

The following table shows the yield and other data with reference to the series of plats used in determining the amount of green matter produced to the acre:

TABLE IX.—*Yields of clover on Field F used in making green-matter determinations, St. Anthony Park, Minn., 1905.*

No.	Source.	Date of first bloom.	Date of full bloom.	Date cut.	Average height when cut.	Green matter to acre.
					Inches.	*Pounds.*
1	Commercial seed (Western Bulked)	June 12	June 28	June 28	30	21,500
2	Western Ohio	June 13	June 27	do	31	20,900
3	Northern Indiana	June 11	June 26	do	30	22,000
4	Southern Indiana	June 9	do	do	30	20,400
5	Illinois	June 10	do	do	30	21,000
6	Missouri	June 12	do	do	28	19,400
7	Iowa	June 13	do	do	28	21,200
8	Commercial seed (not inoculated)	do	June 28	do	27	20,100
9	Commercial seed (inoculated)	June 12	do	do	28	19,900
10	Michigan	June 11	June 27	do	28	18,900
11	Nebraska	June 10	June 28	do	30	21,300
12	Eastern Ohio	June 11	June 27	do	30	21,700
13	Kentucky	June 12	June 25	do	20	21,400
14	Tennessee	June 11	June 27	do	30	18,000
15	Kief, Russia	June 10	June 25	do	29	21,000
16	Orel, Russia	June 15	(Practically no blossoms.)	do	30	24,100
17	Mogileff, Russia	June	June 30	do	31	24,400
18	Courland, Russia	June 15	June 27	do	28	20,000
19	Wisconsin	June 12	June 28	do	28	21,900
20	Oregon	June 13	June 27	do	27	20,000
21	Pennsylvania	June 12	do	do	26	20,600

COMPARISON OF CLOVER NO. 16 WITH OTHER STRAINS.

An inspection of Table IX shows that clovers Nos. 16 and 17, from Orel and Mogileff, respectively, were the heaviest producers of green matter, the yield of the latter being the greater. In this connection it should be noted that No. 17 was harvested after coming almost into full bloom, while No. 16, according to notes taken on the date of cutting, had practically no blossoms. From this it seems probable that the Orel clover was harvested fully two weeks before it had reached the same state of maturity that had been attained by the other strains. Despite this fact it was outranked in yield only by the strain from Mogileff, which lacked but two days of being in full bloom. There can be no doubt that the Orel strain would have given a yield of several thousand pounds more to the acre had it been allowed to reach the stage of maturity at which it is customary to cut clover for hay.

The Orel clover exhibited the same fineness of texture, absence of hairiness, erect habit of growth, succulence, etc., that were observed on the plats in Nebraska and South Dakota. These qualities are not by any means common to all of the Russian strains with which experiments have been made. Another strain not used in the States under discussion, obtained from Ufa, in the cold, almost snowless steppe region of eastern Russia, resembles No. 16 very strikingly. Nos. 15 and 17 resemble the foregoing in some of their qualities, but like No. 18, which in these respects is practically identical with the American strains, they are readily distinguishable in the field.

The lowest yield was given by the seed from Tennessee. The strains that produced less than 20,000 pounds of green matter are the Tennessee, Michigan, Missouri, and commercial sample No. 9. The largest yield produced by seed from domestic sources was 22,000 pounds in the case of No. 3 from northern Indiana.

YIELDS OF FIELD-CURED HAY.

Table X shows the yield to the acre and other data regarding Field W, which was devoted to determining the comparative production of field-cured hay.

Table X.—*Yields of clover on Field W, used in determining the production of field-cured hay, St. Anthony Park, Minn., 1905.*

No.	Source.	Date of first bloom.	Date of full bloom.	Date when cut.	Average height when cut.	Field-cured hay to acre.
					Inches.	*Pounds.*
1	Commercial seed (Western Bulked)	June 13	June 28	June 30	30	4,320
2	Western Ohio	do	June 27	June 29	31	4,248
3	Northern Indiana	June 15	June 28	do	30	4,468
4	Southern Indiana	June 14	June 27	do	30	4,800
5	Illinois	June 11	June 26	June 30	30	4,068
6	Missouri	do	June 25	do	28	4,400
7	Iowa	June 13	June 26	June 29	28	4,120
8	Commercial seed (not inoculated)	June 11	June 28	June 30	27	4,420
9	Commercial seed (inoculated)	June 12	June 29	do	28	4,394
10	Michigan	June 10	June 27	June 29	28	4,109
11	Nebraska	June 15	do	do	30	4,308
12	Eastern Ohio	June 12	June 26	do	30	4,800
13	Kentucky	June 11	June 27	do	30	4,120
14	Tennessee	do	June 25	do	30	3,640
15	Kief, Russia	June 13	June 28	June 30	29	4,020
16	Orel, Russia	June 16	(Few blossoms.)	do	30	5,320
17	Mogileff, Russia	June 15	June 30	do	31	5,000
18	Courland, Russia	June 13	June 27	do	28	3,780
19	Wisconsin	June 12	June 26	June 29	28	3,760
20	Oregon	June 13	do	June 30	27	4,460
21	Pennsylvania	June 10	do	June 29	26	4,480
	Total					91,035

ORDER IN WHICH THE VARIOUS STRAINS MATURED.

A variability similar in some respects to that observed in Nebraska may be noted with reference to the length of time required to mature the different strains. On the University farm they reached the proper stage for harvesting in the groups given below, those maturing earliest being given first:

Group I.—Missouri; Tennessee.
Group II.—Illinois; Iowa; Wisconsin; Oregon; Pennsylvania; eastern Ohio.
Group III.—Kentucky; western Ohio; southern Indiana; Courland; Nebraska; Michigan.
Group IV.—Northern Indiana; commercial samples 1, 8, and 9; Kief.
Group V.—Mogileff.
Group VI.—Orel.

COMPARISON OF YIELDS OF FIELD-CURED HAY.

The lowest yield of the domestic varieties was 3,640 pounds, produced by the Tennessee seed, while the highest was 4,800 pounds, produced by the seed from eastern Ohio and southern Indiana. No. 18, from Courland, gave the lowest yield of the Russian sorts, 3,780 pounds, while No. 16, from Orel, gave the largest return of any variety in the test, 5,320 pounds. No. 16 was harvested on June 30, when it was still very immature, having but few blossoms. Inasmuch as increase in substance is progressing most rapidly in the period leading up to and just preceding full maturity, it is very probable that the Orel clover would have given a considerably higher yield had it been allowed to mature properly. Judging from the performance of this variety at other stations it should have been cut from ten to twelve days later than was the case. This fact should be borne in mind when noting that No. 16 yielded only 520 pounds more than its nearest competitor, 1,176 pounds more than the average for all plats, and 1,600 pounds more than the poorest strains.

THE EXPERIMENT IN NORTH DAKOTA.

LOCATION, SOIL, AND DRAINAGE.

The experiment in North Dakota was conducted on the Experiment Station farm, near Fargo, in cooperation with Prof. J. H. Shepperd, who has been assisted by Mr. O. O. Churchill.

On account of the fact that a larger area was not available, the test was made on half-acre plats. With one or two exceptions the same series of varieties was used as in Nebraska, South Dakota, and Minnesota.

The field used has a wonderfully uniform soil, consisting of jet black clay loam several feet in depth. It is rich in organic matter and in lime, both in the form of carbonate and sulphate. The subsoil is a silty clay of grayish-brown color, which extends to a depth of about 6 feet. The surface soil seems to have a slight admixture of the heavy, black, waxy, clay soil locally called "gumbo." The general soil of the field is quite typical of the best soil in the Red River Valley.

Continuous cropping with wheat has seriously depleted most of the soils of this valley, and they no longer produce the abundant yields that characterized them from ten to twenty years ago. No systematic rotation of crops containing a legume is in general use, and to this may justly be attributed the gradual running down of yields of the cereals which have hitherto been cultivated almost exclusively. The growing of clover is an undeveloped industry in North Dakota. This is due in great part to the fact that wheat farming has hitherto been so profitable, and to the further fact that until recently a general impression has prevailed that clover growing could not be carried on with success. The work of the State Experiment Station during recent years has amply demonstrated that eastern North Dakota, at least, may be considered as peculiarly adapted to clover culture. The writer has never seen anywhere in the clover-growing regions of the United States a finer field of clover than that on which this experiment with regional varieties was conducted. (Pl. III, fig. 1.)

The drainage of the experimental tract is, in common with most of the soils of the Red River Valley, rather poor. This applies to both surface drainage and underdrainage, and is due to the practically "dead level" of the country, which gives the rivers draining the area a very slight fall, and also to the impermeability of the soil to water. In this connection a fact of some interest and possible importance was noted during the summer of 1905, when on account of the wetness of the season it was impossible to harvest a large percentage of the wheat crop of the valley. The clover field, on account of the magnitude of the transpiration of this crop, repeatedly became dry enough to cut after a few days of sunshine, while the neighboring fields of ripened wheat never dried out sufficiently to permit of their being harvested. In regions having heavy soils, where the most rigid conservation of moisture is not necessary, this fact may furnish an added reason for every farmer's sowing clover seed at the rate of from three to six pounds per acre with all of his small grains.

PREPARATION OF LAND, SEEDING, AND SUBSEQUENT TREATMENT.

In regard to the crops previously grown on the field, preparation of the seed bed, nurse crop used, and notes concerning the growth of the strains during the first year, the data below are given from Professor Shepperd's annual report for 1904.[a]

The land used for this trial produced a crop of corn in 1902, barley in 1903, and clover trial plats were seeded with wheat as a nurse crop in 1904. The field had been fall-plowed in 1903. It was disked on May 10 and harrowed twice with a peg-toothed harrow on May 11. The land was very wet in the spring and after the excess of water finally evaporated a period of very dry weather caused the soil to bake. The seed bed was far from being in an ideal condition on May 12, the date upon which the wheat was seeded. The wheat was sown at the rate of 5 pecks per acre with Fife seed. Four days later the clover seed was sown by hand at a rate slightly less than 10 pounds per acre. The clover seed was covered by harrowing with a peg-toothed harrow.

Notes recorded June 15 state that the wheat was showing a good stand and that the clover plants had appeared above the surface. On the above date it was observed that the clover was showing especially well upon the higher places in the almost level field.

On the dates July 25 and 26, the wheat, which was just forming kernels, was cut for hay and removed from the field. The sickle bar was set as high as the machine would allow and left the stubble about 5 inches high. The best of the clover was so high upon that date that it was clipped off by the sickle.

On August 2 Missouri (No. 6), Eastern Ohio (No. 12), Russian (No. 15), and Wisconsin (No. 19) made a much better showing than the plats from other sources of seed. Observations recorded on September 10 show especially favorable to Missouri (No. 6) and Wisconsin (No. 19), while Illinois (No. 5) and Russian (No. 15) were also reported as showing well.

WEATHER CONDITIONS DURING 1904 AND 1905.

On September 10, 1904, immediately after which date a killing frost occurred, there seemed to be a sufficient growth of clover and of wheat stubble to form a moderate winter protection for the clover plats.

With the exception of August, which had a total precipitation of only 0.69 inch, there was an abundance of moisture throughout the growing season. The mean temperature during June, July, and August was from 2 to 5 degrees below normal.

The winter of 1904–5 was quite severe, but in spite of the long-continued cold and low temperatures no loss due to winterkilling was observed on any of the plats.

According to notes taken on May 1 the strains from Mogileff, Courland, Michigan, Kentucky, and Tennessee, in the order given, showed the poorest stands. The best stand of all was on the Illinois plat, which was closely seconded by those sown to seed from eastern Ohio and Nebraska.

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[a] Fifteenth Annual Report, North Dakota Agricultural Experiment Station, pp. 96–97.

The following table shows the comparative yield of each variety under experiment, also date of first bloom, full bloom, and cutting, and average height of plants when cut:

Table XI.—*Yield, time of first and full bloom, height, and date of cutting of clover at Fargo, N. Dak., 1905.*

No.	Source.	Date of first bloom.	Date of full bloom.	Date when cut.	Average height when cut.	Yield.
					Inches.	*Pounds.*
1	Commercial seed (Western Bulked)	June 20	July 8	July 8	30	5,220
2	Western Ohio	do	July 7	do	27	4,950
3	Northern Indiana	do	do	do	29	4,484
4	Southern Indiana	do	do	do	29	4,860
5	Illinois	do	do	do	28	4,830
6	Missouri	do	do	do	29	5,510
7	Iowa	do	do	do	29	3,960
8	Commercial seed (not inoculated)	do	do	do	30	4,680
9	Commercial seed (inoculated)	do	do	do	30	4,140
10	Michigan	do	do	do	32	3,750
11	Nebraska	do	do	do	28	5,080
12	Eastern Ohio	do	do	do	32	5,370
13	Kentucky	do	do	July 10	27	4,610
14	Tennessee	do	do	do	30	5,090
15	Kief, Russia	do	do	do	28	4,200
16	Orel, Russia	(No blossoms when cut.)		do	34	4,062
17	Mogileff, Russia	(Few blossoms when cut.)		do	28	4,350
18	Courland, Russia	June 20	July 7	do	30	4,470
19	Wisconsin	do	do	do	28	4,380
20	Oregon	do	do	do	28	4,300

COMPARISON OF YIELDS.

The heaviest yields of American strains of clover of known origin were secured from the Missouri and eastern Ohio samples, followed rather closely by those from Tennessee and Nebraska. The lightest yields of the American strains were obtained from seed from Michigan, Wisconsin, and Oregon.

The Russian strains were among those giving the lowest yields, the Orel clover yielding next to Michigan seed, the lightest crop. Clover No. 18, the earliest in maturing, produced the largest crop of the Russian sorts.

The low yield of clover No. 16 is adequately accounted for by the fact that in order to insure the securing of seed of this variety the plat was cut two weeks before it had properly matured. Plate III, figure 1, shows the Orel clover, immature and without blossoms, in the foreground, the more mature Russian form from Kief in the near background, and the fully matured Tennessee plat in the farther background.

Here, again, the hairless form exhibited all of the desirable forage qualities noted at the other stations, and but for being harvested so exceedingly early would no doubt have shown the same yielding qualities as elsewhere.

The following table summarizes the yields of each of the varieties grown in the experiments described above:

TABLE XII.—*Comparison of yields of field-cured clover hay at all northwestern stations, 1905.*

No.	Source.	Nebraska.	South Dakota.	Minnesota.	North Dakota.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1	Commercial seed (Western Bulked)	5,700	4,400	4,320	5,220
2	Western Ohio	4,980	3,500	4,248	4,950
3	Northern Indiana	4,780	2,510	4,468	4,484
4	Southern Indiana	5,020	2,710	4,800	4,860
5	Illinois	4,990	3,990	4,068	4,830
6	Missouri	5,010	4,450	4,400	5,510
7	Iowa	3,750	4,130	4,120	3,960
8	Commercial seed (not inoculated)	5,950	3,998	4,420	4,680
9	Commercial seed (inoculated)	6,040	4,312	4,394	4,140
10	Michigan	5,570	4,400	4,109	3,750
11	Nebraska	3,590	4,500	4,308	5,080
12	Eastern Ohio	5,080	4,640	4,800	5,370
13	Kentucky	5,540	3,420	4,120	4,610
14	Tennessee	4,670	3,970	3,640	5,090
15	Kief, Russia	5,840	4,080	4,020	4,200
16	Orel, Russia	7,100	5,610	5,320	4,062
17	Mogileff, Russia	5,750	4,030	5,000	4,350
18	Courland, Russia	4,570	3,280	3,780	4,470
19	Wisconsin	4,950	2,970	3,760	4,380
20	Oregon	4,930	4,560	4,460	4,300
21	Pennsylvania	4,460	1,800	4,480	....
22	New York	....	2,400	....	....

OTHER EXPERIMENTS IN WHICH CLOVER NO. 16 WAS INCLUDED.

In addition to the Northwestern States already mentioned, to whose conditions the hairless clover seems best adapted and where its performance has been described in some detail, this form was also grown in the following sections:

(1) In Ohio, in cooperation with the Agricultural Experiment Station, on the farm of Mr. E. D. McIntyre, near Wooster. The work here was under the direction of Prof. C. E. Thorne, director of the station.

(2) In Canada, on the farm of the Ontario Agricultural College and Experiment Station. The work here was done under the immediate direction of Prof. C. A. Zavitz, experimentalist.

(3) In Indiana, in cooperation with Mr. Theo. H. Reed, on the farm of Mr. L. B. Harris, near Rushville, Rush County. This county is in the heart of the heaviest clover-seed-producing section in the United States and, according to the census of 1900, produced more clover seed than any county in the country.

At Wooster the Orel clover gave one of the highest yields, while at Rushville it produced one of the poorest crops of all the varieties tested, which was probably due to the fact that it was harvested before maturing. Although its forage qualities and botanical characters were identical with those exhibited at other stations, this variety does not seem to be particularly adapted to the conditions existing in Ohio and Indiana.

In Ontario, however, the Orel clover and a somewhat similar form from Ufa gave the heaviest yields. The data for this station are so complete that they are given in full in the following table. A number of varieties were here included that were not used in experiments in the States previously described. The data for these are also included. The experiment was made on small plats, from which the acre yields have been computed. (See Pl. III, fig. 2.)

Table XIII.—*Yield and other data for clover grown at Guelph, Ontario, in 1905.*

No.	Source of seed.	Date of first bloom.	Date of full bloom.	Date when cut.	Average height when cut.	Yield of green matter to acre.	Yield of cured hay to acre.
					Inches.	*Pounds.*	*Pounds.*
1	Commercial seed (Western Bulked).	June 15	July 2	July 13	30	18,640	3,633
2	Western Ohio	June 16	June 28	July 3	30	18,120	2,760
3	Northern Indiana	June 15	June 27	June 30	26	19,080	2,960
4	Southern Indiana	June 13	do	June 29	26	18,400	2,440
5	Illinois	do	do	June 30	27	18,240	2,720
6	Missouri	do	do	July 3	27	16,280	2,640
7	Iowa	June 15	do	do	27	16,880	2,320
8	Commercial seed (not inoculated).	do	June 30	July 7	29½	18,080	3,520
9	Commercial seed (inoculated)	do	June 29	do	28½	18,360	3,520
10	Michigan	June 13	June 26	June 29	27½	18,200	2,240
11	Nebraska	do	June 27	June 30	27½	18,920	2,720
12	Eastern Ohio	do	do	do	26	17,160	2.320
13	Kentucky	June 14	June 28	July 5	27½	17,120	2,840
14	Tennessee	do	June 29	do	29½	17,680	2,800
15	Kief, Russia	June 17	June 30	July 11	27½	15,560	2,800
16	Orel, Russia	June 18	July 14	July 16	26½	20,800	4,360
17	Mogileff, Russia	June 17	July 2	July 13	30	19,320	4,080
18	Courland, Russia	June 14	June 29	July 5	29	23,280	2,880
19	Wisconsin	June 13	June 27	July 6	28½	17,240	2,960
20	Oregon	do	June 28	do	29½	16,880	2,680
21	Pennsylvania	do	June 26	July 2	27½	19,000	2,960
22	New York	June 16	June 29	July 7	29½	19,280	3,640
24	Vitebsk, Russia	June 14	do	July 6	30½	19,360	3,200
25	Perm, Russia	June 16	do	July 12	31	18,840	3,680
28	Ufa, Russia	June 18	July 8	July 17	26	21,040	4,520
29	Kief, Russia	June 16	July 2	July 11	29½	20,240	3,440

Here, again, as was the case in the Northwest, the hairless Orel clover was the latest variety in maturing, and in yield it was surpassed only by the strain from Ufa. The Michigan seed gave the lowest yield of all, 2,240 pounds, while the New York seed gave the highest of the American strains of known origin, 3,640 pounds.

Clover No. 16 yielded 2,120 pounds more than the poorest and 720 pounds more than the best domestic strain, and it produced 1,600 pounds more than the average of all plats.

The same characters and qualities previously noted in this variety were found constant in this experiment.

The record of mean temperatures and precipitation at Guelph for the months of the growing season of 1905 up to and including the time of harvesting the hay crop, in comparison with the normals for the same months at Orel, follows:

TABLE XIV.—*Temperature and rainfall for certain months during 1905 at Guelph, Ontario, compared with the normals for the same months at Orel, Russia.*

Month.	Temperature.		Precipitation.	
	Guelph.	Orel.[a]	Guelph.	Orel.[b]
	Mean.	Normal.	Total.	Normal.
	°*F.*	°*F.*	*Inches.*	*Inches.*
April	41.15	38.08	1.75	1.57
May	52.84	56.10	3.89	1.87
June	62.58	63.55	3.54	1.97
July	67.67	67.76	4.66	2.80

[a] Wild, Die Temperaturverhältnisse des Russischen Reiches, St. Petersburg, 1881.
[b] Wild, Die Regenverhältnisse des Russischen Reiches, St. Petersburg, 1887.

DESCRIPTION OF NEW TYPE AND NAME PROPOSED.

Although American red clovers from widely separated sources vary greatly among themselves, these variations do not appear to be constant and are not of sufficient importance in any case to justify the giving of varietal rank in the botanical sense to any of the regional strains of domestic origin used in these experiments. On the other hand, the distinctions between the hairless Orel clover and the American clovers are so numerous and well defined in the plant itself, though not apparent in the seed, that it seems advisable, on account of the probable economic importance of the former, to give it a distinct varietal name. Almost complete lack of hairiness is perhaps the most striking distinguishing mark of this form in the field, but the variability in amount of hairiness, differing as it does even in American strains from more or less widely separated sources, makes this an undesirable quality on which to base a name. On account of the value both from an economic standpoint and as a botanical character of the general leafiness of the plant and the persistence and number of basal leaves produced, the writer proposes for this variety the designation *Trifolium pratense* var. *foliosum*, based on these characters. A type specimen has been deposited in the National Herbarium.

In addition to lack of hairiness and the unusual leafing qualities referred to above, the plants of this variety have a more upright habit of growth and branch more freely than the American form. Besides the foregoing, there are other differences of a more purely botanical character. The white spots on the leaflets which are so prominent in the ordinary form are frequently absent from plants of this variety and often when present can scarcely be seen. The largest mature leaves of the smooth clover are about the same size as the smallest of the American strains. The flower heads are also smaller, less compact, and rather more elongate than those of the latter. The bracts subtending the inflorescences are smaller in this form; also more circular in outline, less prominently nerved, of finer texture, and glabrous throughout except at the apex, which is sometimes tipped with a few slender hairs. In the American form the under side and margin of these bracts are covered with many fine hairs.

The stipules also show some constant dissimilarities. On plants of equal age the stipules of the American strains are larger, hairy on the back, margins, and tip, and in the cured hay are harsh and woody; in the Orel clover they are smaller, of finer texture, much less prominently veined, and hairless except at the tip, where there is usually a tuft of hairs. According to a comparison of a large number of measurements of the stipules and petioles of the basal leaves of both forms, although the stipules of No. 16 are shorter, the petioles are longer. In the former the stipules constitute about 8 per cent of the total length; in the latter, about 15 per cent. The average length of the stipules in both No. 16 and the American forms was found to be 22 mm. and 24 mm., respectively, and of the petioles 270 mm. and 160 mm., respectively. The same proportion was not found to hold true in regard to the leaves of flower-bearing stems. In these, both the stipules and petioles, comparing similar parts of plants of about equal development, are shorter in the hairless form. The average lengths of stipules and petioles in the latter are 20 mm. and 104 mm., while in the domestic form they are 22 mm. and 114 mm., respectively. (See Pl. II, fig. 1.)

The calyx of the smooth clover is sparingly covered with short, appressed hairs, while in the hairy American form it is densely covered with more erect hairs, which are in general from 1½ to 2½ times longer. The calyx in both forms is five-toothed, one tooth being considerably longer than the other four. In the American form the long tooth appears to be always more than twice as long as the four short ones, which are of about equal length, while in the variety *foliosum* the long tooth seems never to be as much as twice as long as the others.

The few hairs that occur on the Orel clover, no matter upon what portion of the plant they are found, are comparatively very short and always appressed to the part bearing them, while in the domestic clover they are numerous, in young plants matted (see Pl. II, fig. 2), and extend at right angles from the organ on which they are borne.

LATER OBSERVATIONS.

Notes taken during May and June of 1906 on the plats in Nebraska and North Dakota, now in their third year, tend to confirm the observations recorded for all stations during the growing season of 1905. In only one case was the seed production of clover No. 16 satisfactory under the method of taking two full crops. This was in southern Indiana, where its yield was fully up to the average for other varieties.

At Carlton, Oreg., on Mr. F. J. Canfield's farm, another late Russian strain, resembling No. 16 in many respects, gave a very satisfactory yield of seed. In this case only one crop, the seed crop, was harvested, the field having previously been pastured quite closely with hogs and sheep until early summer. Although cut at the same time as the earlier strains, the late Russian form indicated such promising yielding qualities as to insure a large crop of seed with proper handling. The need for having all strains ready to hull at the same time made necessary the too early cutting of this strain, which was obtained from Ufa and has been previously referred to in connection with the experiment in Ontario.

From the observations made on the seed production of clover No. 16, it is evident that the chief obstacle to the successful introduction of the new variety into commercial culture rests on the fact that seed true to type will be difficult to secure, and when it has been secured it will require some time before a sufficient quantity will have been propagated to sow any considerable area. For this reason it is suggested that growers securing seed of this variety from any source whatever should devote the greater part of their field to seed production. On account of its lateness it may not be possible, except in southern parts of the clover region, where the seasons are long, to secure both a hay and a seed crop in any one year. Therefore growers in the North and Northwest are advised not to attempt to secure two full crops, but rather to mow a light crop of hay late in May—say, between May 20 and June 1—and then allow the field to go to seed. In sections where the practice of pasturing is permissible it may prove more profitable to pasture the fields until about May 25 instead of taking off an early cutting. The date of this cutting or of the pasturing will of course vary in different sections.

On account of the persistence of the leaves and the general character of plant, the straw that remains after hulling clover No. 16 should furnish considerably more feed than that of the hairy type of clover.

The fact that the seedlings of the new clover are almost absolutely free from hairiness may prove a help in determining the genuineness of any sample. Where seed is purchased long enough in advance of seeding to make it possible, the germination test could be prolonged in pots for thirty days with a view to examining the seedlings. By this time the ordinary clovers are very hairy, while No. 16 remains almost perfectly smooth.

The Department of Agriculture is making an effort to secure a new importation from the same source as the original seed used in these experiments. This seed when obtained will be planted for the most part in large fields in order to secure a supply for use in distribution and for experimental work.

A very interesting fact in connection with the 3-year-old plats of the Orel clover, indicating either unusual cold-resisting qualities or a tendency to become perennial, was noted both at Fargo, N. Dak., and at Oakland, Nebr. In both of these cases the new type has the best stand remaining of all the 20 or 21 strains used in the experiment; in fact, at Oakland, No. 16 is the only plat on the field that has a full stand.

In a report dated June 25, 1906, just received from Mr. John P. Young, he states that with the exception of Russian clover No. 16 all of the plats have but a light sprinkling of plants from the old seed, and he is of the opinion that the majority of these were produced from seed matured in the autumn of the seeding year 1904. On a large portion of the field not more than one or two plants appear on 10 square feet of ground. Returning again to the Orel clover, Mr. Young refers to its upright habit, abundant foliage, soft velvety texture, and the preference that cattle show for it, and states that "it is the only strain on the whole field that has a full stand from the first seeding."

This tendency to become perennial, the absence of hairiness, and the other desirable qualities mentioned by Mr. Young continue to distinguish the new form from the ordinary type of red clover now in use.

SUMMARY.

Red clover, on account of its great value as a forage plant and because of its power of renewing and maintaining the fertility of the soil, is one of the most important crop plants of modern agriculture.

In the course of an extensive experiment with seed from different sources there appeared a variety, hitherto not used in the United States, possessing certain advantageous qualities which make it desirable to introduce it into American farming.

The seed of this variety was secured from the "Black Earth" region in the eastern part of the Orel government of Russia. The soil and climate of this section resemble strikingly those of our own northwestern prairie country, particularly Nebraska, Minnesota, and the Dakotas.

This variety is distinguished by the dustlessness of its hay, due to almost complete absence of hairiness from all parts of the plant, by its heavy yields for the first crop, by its leafiness and the persistence of the basal leaves, by the succulence of the stems, which improves greatly the quality of the hay and reduces the waste due to woody, uneatable portions, by greater palatability than hay from domestic seed, and by the fact that it comes to proper maturity for harvesting from ten days to two weeks later than the ordinary American red clover.

Except in certain sections and for certain purposes this variety is not recommended for supplanting domestic red clover, but rather for supplementing the latter.

Although the hairless Orel clover can be readily distinguished from the American form on the field, there is no apparent difference in the seed. The Department of Agriculture has at the present time no seed for general distribution, the supply on hand being sufficient only for purposes of experimental propagation.

Before purchasing seed from foreign sources, purporting to be of this variety, farmers are urged to take special precautions against the introduction of dangerous weed pests and to assure themselves as far as possible as to the genuineness of the seed.

PLATES.

DESCRIPTION OF PLATES.

Plate I. *Frontispiece.* Fig. 1.—Plant of hairless Orel clover, almost mature. Fig. 2.—Mature plant of American red clover.

A portion of the plant from which figure 1 was made has been deposited in the United States National Herbarium (No. 409983) as a type specimen of *Trifolium pratense* var. *foliosum.* Formalin material from the same plant is preserved in the Laboratory of Plant Life History.

Plate II. Fig. 1.—Stems, stipules, and bases of petioles of American and of hairless Orel clover (1½ times natural size). Fig. 2.—Young plants of hairless Orel clover and American red clover, showing smooth and hairy types (five-eighths natural size).

The photographs from which Plates I and II were made are of seventeen-months-old plants of the second crop, grown on the farm of the Minnesota Experiment Station, at St. Anthony Park.

Plate III. Fig. 1.—Large plats used in clover experiments, North Dakota Agricultural College, Agricultural College, N. Dak. (Negative by O. O. Churchill.) Fig. 2.—Small plats used in experimental work, Ontario Agricultural College and Experiment Station, Guelph, Ontario. (Photograph furnished by Prof. C. A. Zavitz.)

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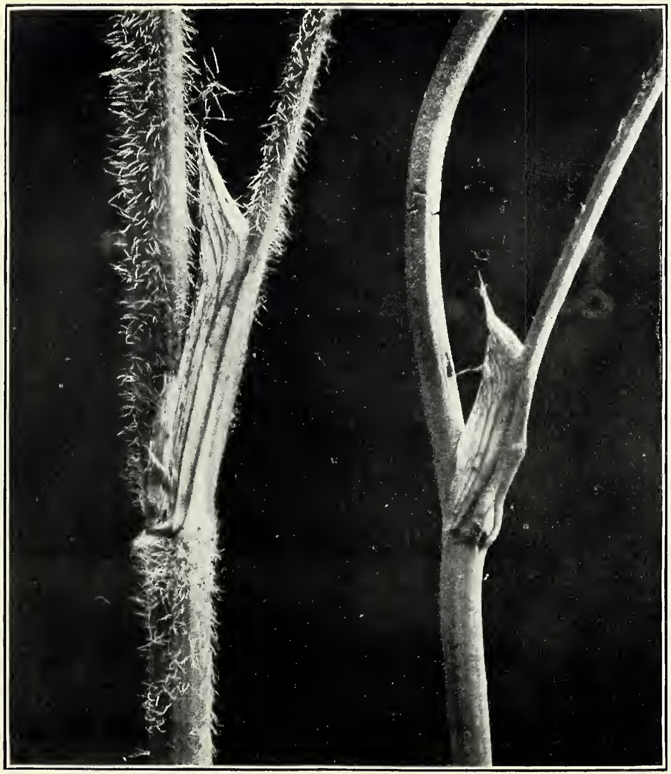

FIG. 1.—STEMS, STIPULES, AND BASES OF PETIOLES OF AMERICAN AND OF HAIRLESS OREL CLOVER. (ONE AND ONE-HALF TIMES NATURAL SIZE.)

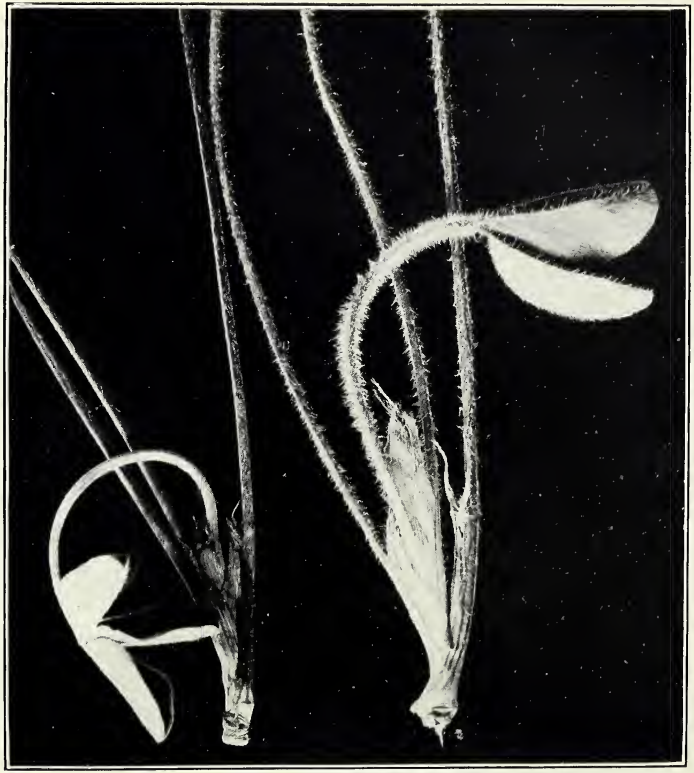

FIG. 2.—YOUNG PLANTS OF HAIRLESS OREL CLOVER AND AMERICAN RED CLOVER, SHOWING SMOOTH AND HAIRY TYPES. (FIVE-EIGHTHS NATURAL SIZE.)

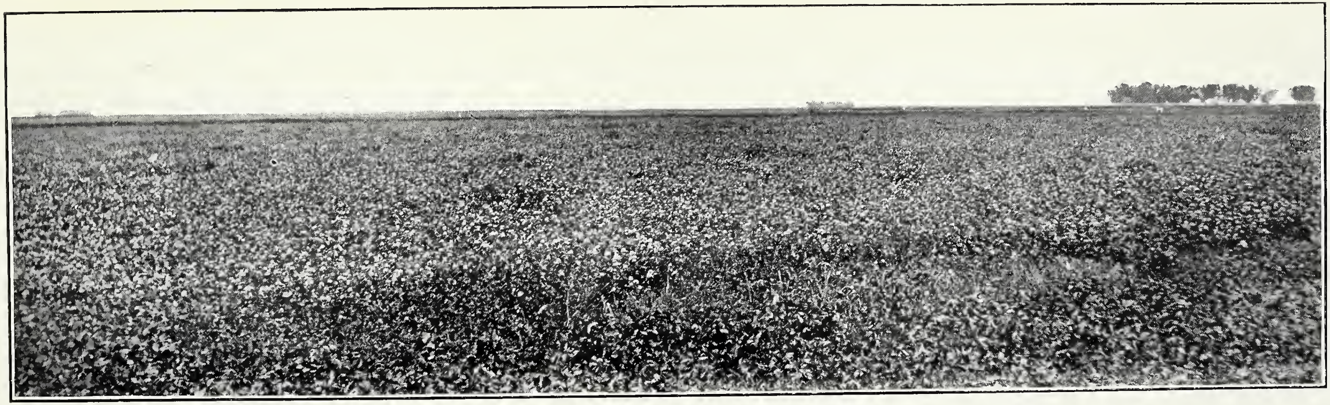

FIG. 1.—LARGE PLATS USED IN CLOVER EXPERIMENTS, NORTH DAKOTA AGRICULTURAL COLLEGE.

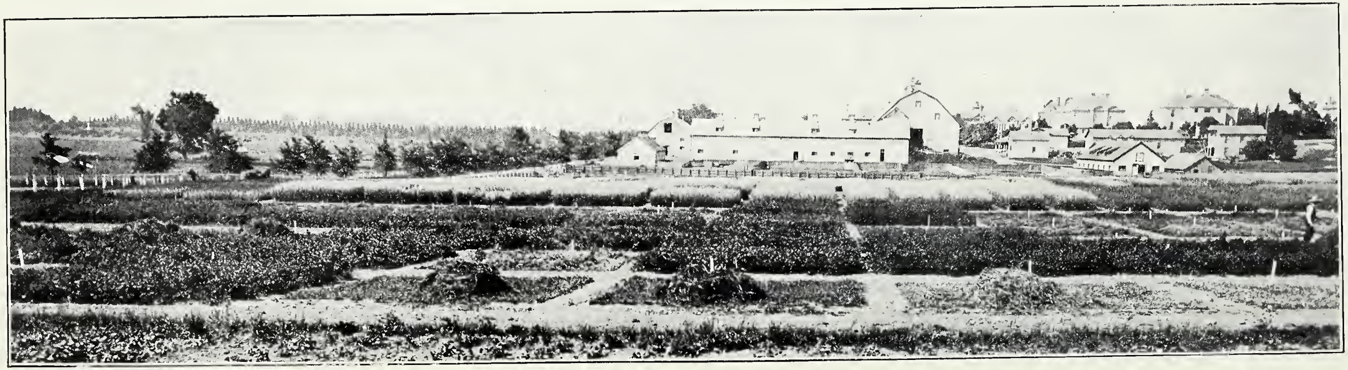

FIG. 2.—SMALL PLATS USED IN EXPERIMENTAL WORK, ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENT STATION, GUELPH CANADA.